BEFORE THE NEW MEXICO PUBLIC REGULATION COMMISSION

IN THE MATTER OF THE APPLICATION OF NEW MEXICO GAS COMPANY, INC. FOR APPROVAL OF REVISIONS TO ITS RATES, RULES, AND CHARGES PURSUANT TO ADVICE NOTICE NOS. 70 AND 71	)	**Case No. 18-_____-UT**
NEW MEXICO GAS COMPANY, INC.	)	
Applicant.	)	

DIRECT TESTIMONY AND EXHIBITS

OF

DEIRDRE M. KANN, Ph.D.

February 26, 2018

DIRECT TESTIMONY OF
DEIRDRE M. KANN, Ph.D.
NMPRC CASE NO. 18-_____-UT

Q. PLEASE STATE YOUR NAME AND BUSINESS ADDRESS.

A. My name is Deirdre M. Kann, and my address is Department of Earth and Planetary Sciences, MSCO3-2040, University of New Mexico, Albuquerque, New Mexico.

Q. BY WHOM ARE YOU CURRENTLY EMPLOYED AND WHAT IS YOUR POSITION AND RESPONSIBILITIES WITH THAT EMPLOYER?

A. I am currently self-employed as an expert in atmospheric and weather related sciences. I am also a part time instructor at the University of New Mexico teaching Meteorology for the Departments of Earth and Planetary Sciences and Geography.

Q. PLEASE DESCRIBE YOUR PROFESSIONAL BACKGROUND.

A. I received a B.S. degree in Mathematics with a minor in Geography from Towson University (formerly Towson State University) in Towson, Maryland; an M.S. degree in Geography (Meteorology) from Northern Illinois University; and a Ph.D. in Atmospheric Sciences from Purdue University. After obtaining my Ph.D., I worked for the National Meteorological Center (now the National Center for Environmental Prediction) for eight years in various positions, including: 1) Postdoctoral Scientist; 2) Research Meteorologist; and 3) Senior Research Scientist. I then joined the National Weather Service and worked for 22 years as the Science and Operations Officer for the Albuquerque National Weather Service Forecast Office.

I have co-authored 9 manuscripts in professional journals, and a recent article for a non-technical weather publication. I have also taught classes at four universities: the University of New Mexico, Johns Hopkins University (Continuing Education), Kishwaukee College, and Northern Illinois University. For additional details relating to my professional background, please see NMGC Exhibit DMK-1.

Q. HAVE YOU EVER TESTIFIED BEFORE?

A. No.

Q. FOR WHAT PURPOSE WERE YOU ENGAGED BY NEW MEXICO GAS COMPANY, INC. AND WHAT IS THE PURPOSE OF YOUR TESTIMONY IN THIS PROCEEDING?

A. New Mexico Gas Company, Inc. ("NMGC" or the "Company") hired me to complete an analysis of weather and climate data in New Mexico. New Mexico is categorized as a steppe or desert climate and dry climates exhibit more year-to-year variability than other climate types. Specifically, I was asked to evaluate various methods for using climate data to estimate the climate component of expected natural gas consumption in the near future, which is based, in part, on weather during the heating season. The focus of my investigation was to analyze weather and climate data since 1971 (when available) to determine what period of time will best predict normal weather in the near future in and around the Company's service territories. Sites representative of New Mexico's climate at or near the population centers in NMGC's service area were selected for this study. I

primarily analyzed weather data related to Heating Degree Days which I obtained from the National Center for Environmental Information ("NCEI").

Q. WHAT ARE HEATING DEGREE DAYS ("HDD")?

A. HDDs are indicators of energy/fuel consumption, and they work by assigning one HDD for each degree that the daily mean temperature is below 65°F. Daily mean temperature is defined as the arithmetic average of the maximum and minimum temperature for a day (and not the average of hourly observations). For example, a day with a mean temperature of 40°F would be assigned 25 HDDs while any day with a mean temperature of 65°F or greater would have zero HDDs. HDDs are lowest in the summer months and peak in winter months. When examined over a year-long period, a heating year is defined as the period from 1 July through 30 June the following calendar year such that a single winter season is included in the annual value of HDDs.

Q. WHY DID YOU USE HDDS IN YOUR ANALYSIS?

A. Heating (and Cooling) Degree Days were developed to relate temperatures to energy demands. It is common to measure energy consumption using HDD, rather than temperatures, because projected consumption of energy, such as natural gas, can be related to the degree to which temperatures are above or below expected values – in this case 65°F. Thus, my analyses were completed using HDDs.

Q. PLEASE SUMMARIZE YOUR CONCLUSIONS.

A. Based on my analyses, the most recent ten-year average generally results in more accurate estimates of the anticipated values of annual HDDs than either a 30-year "most recent" average or the 30-year normal computed by the NCEI (formerly the National Climatic Data Center, "NCDC"). Data from every site I examined shows an increase in temperature with a corresponding decrease in HDDs for various periods starting in 1971, although the amount of warming varies from site to site and year-to-year variability exists as expected. Regardless, during a period of warming as has been documented in New Mexico, the most recent 10-year averages are better estimates of the current and short-term future climate conditions than NCEI 30-year normals.

Q. WOULD YOU PLEASE BRIEFLY SUMMARIZE THE APPROACH YOU USED IN YOUR ANALYSIS?

A. I initially examined area-average temperatures for the eight climate divisions in New Mexico and confirmed the trend of increased temperatures in all divisions. For my site analysis, I obtained monthly values of HDDs since 1971 (or the earliest date possible) from eight sites in New Mexico in or near the cities of: 1) Albuquerque, 2) Gallup, 3) Roswell, 4) Las Cruces, 5) Tucumcari, 6) Farmington, 7) Los Alamos, and 8) Truth or Consequences. The monthly HDD values for the eight sites were obtained from NCEI, as were the 30-year normal values for the period 1981-2010.

Monthly HDD values from these sites were summed for the 12-month period from July 1 through June 30 to determine HDD accumulations for heating years. For all but two stations, these accumulations were calculated for heating years 1971-1972 through 2016-2017. The heating year values for each site were analyzed using a linear regression, resulting in a line in the set of values that illustrates the relationship, or trend, in the data series. Annual values of heating degree days are fairly variable from year to year, and the year-to-year changes were smoothed by computing 10-year averages for each year to estimate variability over longer (decadal) time periods. Finally, an evaluation of how well the NCEI normal, the most recent 30-year average and 10-year average can be used as predictors of heating degree days was completed by computing the differences in the observed HDDs and the normal or estimates. The sign and magnitude of the differences is referred to as the bias, or the difference between the expected number of HDDs and actual number of HDDs. Because biases of opposite sign result in a small average value, absolute errors that consider the magnitude of error but not the sign were also calculated.

Q. HOW DID YOU CHOOSE THE SITES YOU USED IN YOUR ANALYSIS?

A. These locations were chosen in-part based on the Company's service area. More importantly, the stations selected had data records from sites that had not moved in location and had very little missing data. Many sites in New Mexico which previously had long and complete data records are now considered inactive or closed, or had multi-year periods of incomplete data resulting in numerous missing values. Sites with missing data were not considered suitable for this study. Though it is important to select sites near population

centers within the Company's service area, the inclusion of rural stations near population centers minimizes the chance of a change in temperatures due to urbanization.

Q. WHY IS IT NECESSARY TO EXAMINE HDD DATA FROM MULTIPLE SITES?

A. New Mexico has an area of just over 120,000 square miles in size and with diverse terrain and a significant elevation range. The considerable expanse combined with terrain results in a wide range of climate conditions across the state. Thus, while large-scale dynamics produce the weather patterns which impact the state, local factors including terrain features, elevation, and surface type also contribute to the resulting climate regimes across the state. Any one site would not be representative of all areas in the Company's service area, and changes observed at one location cannot be assumed to have occurred at another.

Urbanization has been shown to impact sites, most often in the form of temperature increases due to heat absorption by buildings, asphalt parking lots and roads, industry emissions, and decreased vegetation. However, most observations sites in New Mexico are not in locations influenced by urbanization, including the sites used for this report with the exception of Albuquerque.

It is also interesting to note that rural stations separated by relatively short distances can have fairly significant differences in the magnitude of observed trends. For all these reasons, multiple sites across the state must be analyzed.

Q. IS THERE AN ESTABLISHED STANDARD FOR CALCULATING "CLIMATIC NORMALS"?

A. For many years, thirty-year averages have been used to define the climate normal. These three-decade averages are updated for locations in the U.S. every ten years by the National Oceanographic and Atmospheric Administration's National Center for Environmental Information. The World Meteorological Organization (WMO) supports this strategy for maintaining the 30-year normal for locations across the globe. For a "stationary" climate, a climate that is not changing or is changing very slowly, a 30-year normal is an accurate measure of a location's climate and, thus, an estimate of the future climate. However, with the well-documented warming trend, a sign of a "non-stationary" climate, a 30-year normal can still be valuable as a measure of the historic record but it is less useful as a predictor of the future state of the climate, which is the purpose of my work in this case.

Q. DO OBSERVED TEMPERATURE TRENDS SIGNIFICANTLY AFFECT CLIMATOLOGICAL ESTIMATES OF FUTURE HDDS?

A. Absolutely. Temperature trends, or a consistent pattern of change in temperatures, make a long-term climatological estimate as a prediction less accurate. U.S. temperatures (and global temperatures as well) show consistent warming over the past three to four decades. Therefore, a 30-year normal temperature used as an estimate of a future temperature is likely to be too cool, resulting in a cool bias. Warming temperatures correspond to a decrease in heating degree days, and a 30-year normal HDD used to estimate a future HDD will likely be too high.

Q. DO OTHER CLIMATE SCIENTISTS AGREE WITH YOUR ASSESSMENT OF THE USE OF 30-YEAR "CLIMATE NORMALS" TO CHARACTERIZE CURRENT CLIMATE?

A. Yes. When NCEI updated the 1971-2000 normals for the period 1981-2010, the decade of 2001-2010 was warmer than the decade dropped from the 30-year period (1971-1980) for many locations including New Mexico (see summary table in NMGC Exhibit DMK- 2). Thus, the new normal was generally a warmer normal, a clear sign of a warming trend and a non-stationary climate.

In 2007, Livezey et al. published research on new approaches to the estimation of climate normals in a non-stationary climate. They concluded that 30-year normals updated every 10 years are no longer useful for decision-making processes for which they were intended. They recommended that improved estimates and forecasts of U.S. Normals be both developed and implemented by NCDC (now NCEI). A few years later, Arguez and Vose (2011) of NCEI published work supporting this proposal, also noting that 30-year normals are not ideal in an era of observed climate change, particularly for use as predictors. Since then, NCEI developed a set of "supplemental" monthly temperature normals with averages over 5-, 10-, 15- and 20-years, and well as other statistical methods, and maintains these additional normals on their web site. NCEI advises users to consider using an alternative normal due to the observed climate change. These normals, however, are still limited to the 30-year period that ends in 2010. Additionally, NCEI has taken a proactive role of

engaging the energy industry to evaluate the current use of climate normals and the energy industry's need for alternative climate normals.

Q. ARE THERE SPECIFIC REASONS WHY 30-YEAR "CLIMATE NORMAL" WEATHER MAY BE INAPPROPRIATE AS AN ESTIMATOR FOR CONDITIONS IN NEW MEXICO?

A. Yes. It is important to note that a 30-year normal computed by NCEI is not just a mathematical average of available data. NCEI uses sophisticated statistical techniques to account for missing data and questionable data, a complicated and lengthy process. When the NCEI normals are updated to include a new decade, the process can take one to three years. It is important to note that the present 1981-2010 normals do not account for the climate observed in the seven most recent years. As such, the most recent climate is excluded from the normal value. During a period of little change, the impact would be minimal. But given that in New Mexico, six of the last seven years have seen temperatures well-above the 30-year normal, the exclusion of these recent values is considerable. Using the 30-year normals devalues the trend observed in the data. Recent research has shown this to be true – Wilks (2013) states that "to the extent that climate means are not stationary, shorter averaging will yield more accurate results." The National Oceanic and Atmospheric Administration's (NOAA's) Climate Prediction Center uses shorter, annually-updated averaging periods for their forecasts of seasonally average temperatures. Climate change must be considered by decision makers.

Q. IS IT POSSIBLE THAT THE WARMING TREND IN NEW MEXICO, AS DEPICTED IN THE DECREASING ANNUAL ACCUMULATIONS OF HDDS OVER THE PAST SEVERAL DECADES, MIGHT NOT CONTINUE INTO THE FUTURE?

A. Such a scenario is not likely. The warming trend in New Mexico is well-documented as it is for much of the globe. Warming has been observed in all seasons in New Mexico, and while the least amount of warming has been observed in the winter, some of the greatest increases have occurred in the spring seasons. Regression analyses result in a linear value of temperature increases, from which future warming can be inferred. But more significant, climate models developed and supported by numerous government, private, and educational entities consistently show warming (and a decrease in HDDs) to continue at least through the mid-21st Century, and likely longer. I agree with the majority of climate experts whose research has shown temperature increases will continue.

While climate models depict warming on relatively large spatial scales, the resulting predictions are not appropriate as forecasts of expected climate on a regional scale. Therefore, the most appropriate basis for determining expected HDD values for energy regulatory purposes is to use statistics derived from the recent local observations within the service area.

Q. DID YOU ANALYZE 30-YEAR WEATHER VERSUS 10-YEAR WEATHER FOR CONDITIONS IN NEW MEXICO?

A. Yes. I analyzed NCEI-computed 30-year climate normal. The NCEI normals currently represent the period from 1981-2010. I also computed averages for the most recent 30-year period, or for heating years ending in 1988 through 2017. Finally, for each heating year, an average of the previous 10 years was computed. All three of these values were evaluated for skills as predictors for a ten-year period by calculating the difference between the expected value (the normal or average) and the measured value for each heating year. The difference is also referred to as a bias, with a positive value representing an overestimate of HDDs.

The differences (biases) at all stations were largest when using the NCEI 30-year normal as a predictor. Biases were reduced when using the most recent 30-year average, but the smallest biases at most stations were obtained using the average of the previous 10-years.

Q. WHAT DO YOU CONCLUDE REGARDING THE APPROPRIATE LENGTH OF CLIMATOLOGICAL BASE PERIOD FOR ESTIMATING HDDS OVER THE NEXT SEVERAL YEARS?

A. In my opinion, the most recent 10-year average is more representative of past weather, making it a superior estimate of near future conditions. The data record shows that the climate of New Mexico is now significantly warmer than it was two or three decades ago. Statistics for most locations depict a steady increase in the decadal update of the 30-year normal. Recent research has documented several alternatives to the 30-year normal, including climate normals for shorter time periods, and other statistical approaches that can

be more suitable when using climate data for predictive values. In fact, NCEI continues to compute a 30-year normal, updated every 10 years, for numerous sites across the county, but now also calculates the normal for several shorter time periods. NCEI notes that "the products were designed to better characterize current or future conditions." NCEI recommends that users of climate data consider the range of estimates depending on their specific applications. In addition to these recommendations, the statistical analyses described here demonstrate that the most recent 10-year average tends to be more representative of current climate than 30-year averages or the NCEI normals.

Q. DOES THIS CONCLUDE YOUR DIRECT TESTIMONY?

A. Yes, it does.

NMGCO#3633264

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AFFIDAVIT OF DEIRDRE M. KANN, PhD

STATE OF NEW MEXICO)
) ss.
COUNTY OF BERNALILLO)

DEIRDRE M. KANN, PhD, Consultant for New Mexico Gas Company, Inc., upon being duly sworn according to law, under oath, deposes and states: I have read the foregoing Direct Testimony and Exhibits and they are true and accurate based on my own personal knowledge and belief.

SIGNED this 5th day of February, 2018.

DEIRDRE M. KANN, PhD

SUBSCRIBED AND SWORN to before me this 5th day of February, 2018.

Notary Public

My commission expires:

2/12/2019

OFFICIAL SEAL
Lisa A. Trujillo
NOTARY PUBLIC
STATE OF NEW MEXICO
My Commission Expires: 2/12/2019